

Cramer-Rao Bounds for Detection of Planetary Images

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Direct imaging is one of the methods under investigation to discover planets around nearby stars. That method implies resolution and estimation of extremely faint signals submerged in the glare of the much brighter host-stars, for example, with the Terrestrial Planet Finder in the coronagraphic mode. Given instrument parameters (such as the point-spread function of source response function), Cramer-Rao lower bounds on photometric detection of a faint, close source are calculated. These bounds can be used to evaluate the smallest separations and the lowest brightness a secondary source should have to be detected at a given signal-to-noise ratio. Cramer-Rao bounds are related to the amount of information in the observational data, and they can be attained, but never surpassed, by a Minimum-Variance Estimator (MVE). In a general framework, photometric MVEs are derived for the angular resolution problem. It is discussed how such an MVE can be realized as a linear filter for the frequently used family of linear observation models with additive noise.

